Channel incremental technology, such as traps, requires the operator to send an installer to a subscriber's location to add or remove equipment whenever the subscriber adds or deletes a channel from its cable service. This technique also can accommodate varying demand for premium channels and pay-per-view, especially the new NVOD services. Time-Warner states that scrambling is particularly well-suited to deployment with fiber-optics and other technologies that expand channel capacity and increase system reliability by decreasing the need for active electronics throughout the distribution system.

Cable respondents state that scrambling is the only method that eliminates the incentive to tamper with the cable plant. They submit that in contrast, "clear signal" technology, such as trapping and interdiction, is vulnerable at any point prior to just outside a subscriber's home. NCTA states that studies that reveal significant leakage around bars and college dormitories provide persuasive evidence that when signals are not scrambled, some individuals will find a way to steal service, often damaging cable plant in the process.

The principal desirable aspect of interdiction is that it provides all purchased channels to a subscriber's premises in the clear. No converter or descrambler device is needed so long as the subscriber's television equipment can tune the full range of available cable channels.[42] On the other hand, cable industry representatives state that interdiction systems, while more flexible than traps, do not have the channel capacity to handle all the channels that must be secured under the new statutory provisions. Cable operators also claim that interdiction systems are more vulnerable to theft of service because signals are carried in the clear on the trunk and distribution portions of the cable system. Finally, the cost of implementing interdiction technology is generally more than other forms of security protection. While interdiction technology has been available for some time now, it has not gained widespread acceptance because of the limitations and problems indicated above.

4. New Security Methods

Several new cable security technologies are being developed. One new technology now under development is broadband descrambling. The basic concept of this technology is to descramble all authorized signals before they enter the subscriber's premises, thereby resolving many of the problems of cable system compatibility with consumer electronics equipment. The proponent of this technology, Multichannel Communication

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[42] Reception problems can still occur, however, if the subscriber's equipment is inadequately shielded or prone to overload.

Sciences, Inc. (MCSI), states that its "Broadband Access Control" system will be compatible with existing baseband or RF sync suppression scrambling methods and that this will allow broadband descrambling to be implemented gradually. MCSI indicates that equipment for its system will be available in the second half of 1994. It further states that the initial cost of subscriber units for broadband scrambling will average about $140, and that the price will decrease with increasing production volume. MCSI submits that headend processing equipment will cost about $20,000 for each group of 10 channels that are scrambled.

Time-Warner expresses a number of concerns about broadband descrambling technology with regard to its possible inclusion in the Commission's plan for compatibility regulation. First, it states that broadband descrambling equipment, as now being designed by MCSI, is only fully compatible with the older sync suppression scrambling method. Time-Warner further contends that this technology has only limited compatibility with the video inversion scrambling technique and is not compatible with modern approaches. It therefore suggests that broadband descrambling will severely limit the options for processing signals to increase security. Time-Warner also adds that the existing broadband scrambling concept shares many of the practical difficulties of interdiction and is also incompatible with video compression.

A second new concept that is often discussed as a possible solution for providing clear channel delivery signals to cable subscribers is "point-of-entry" (POE) security. This approach is actually not a new security method per se, but is rather an implementation of one or more of the existing security methods in a device located outdoors at the subscriber's premises. The POE device would provide all authorized signals in the clear at the terminals of the subscriber's equipment. The POE device can contain any one of a descrambler, jammer (interdiction), digital decompressor, broadband descrambler or set of traps. At present, however, no one has indicated definite plans to manufacture and/or market POE products.

Another new approach for signal security is for cable systems to use narrowband switching systems to provide a video dial-tone service. Supporters of this approach argue that it would allow cable systems to maximize the services available on their broadband communications path and potentially eliminate the need for scrambling. Time-Warner argues that switching would not be workable on existing broadband cable networks. It points out that the architecture of broadband networks is such that the services provided to multiple subscribers share the same physical facilities simultaneously. On this basis, interception of unauthorized signals would be relatively easy if those signals were not protected.

A fourth new idea that takes still another approach is a system being developed by Watson Associates that monitors the specific channels being received by subscribers. The "Watson Time Usage Cable TV System" will be pole mounted and will be capable of detecting the channels to which a subscriber's own receiving equipment is tuned, without special equipment in the home. The basic premise of this approach is not to restrict access to signals, but rather to allow cable systems to charge for all services a subscriber chooses to watch.

5. Statutory Considerations in Selection of Security Systems

Parties representing cable interests submit that the must carry/retransmission consent and buy-through provisions of the 1992 Cable Act complicate the task of providing security for their programming. Under the must carry/retransmission consent provisions, local broadcasters will have the option every three years of selecting must carry status, which carries with it a right to on-channel positioning, or retransmission consent. If, for example, a local broadcaster elects must carry status and the broadcast channel is currently occupied by a trapped premium service, the operator of a trapped system would have to retrap its entire system to accommodate this one change. This would be both a capital and labor intensive process. The cost of such retrapping would be very high and, as noted above, there are practical considerations that limit the number of traps that can be used on a single cable tap. The alternative for a trapped system is to set aside vacant channels for must-carry eligible broadcast signals not carried as a result of a triennial election decision to offset the chance that those stations may choose to be carried at a future time.

Cable operators point out that, in general, it is easier to manage signal security where all of the channels in a tier are grouped together in the same area of the spectrum. Carriage of must-carry TV stations according to the on-channel position rights provided in the 1992 Cable Act will typically result in the basic tier of service consisting of channels that are non-contiguous in the spectrum. According to the cable industry, this poses problems for protection of expanded basic and/or premium channels that a cable operator might need to carry on channels adjacent to channels in the basic tier. In these cases, a means is needed to protect multiple non-contiguous channels.

According to cable interests, the signal security problems posed by must carry/retransmission consent are further complicated by the buy-through provisions. These provisions require cable operators with the capability to do so to offer any programming offered on a per-program or per-channel basis to basic-only subscribers, and prohibit operators from requiring subscribers to take an intermediate, or "extended basic," tier to receive such programming. According to the cable industry, each

premium service will, therefore, have to be individually secured. NCTA states that cable operators with trapped systems that offer a broadcast and Public-Educational-Government (PEG) channels "basic only" tier to subscribers would likely have to use a complex arrangement of three or four traps, depending on the number and location of premium channels on the system and which of those a subscriber purchases. In any event, the number of premium services a cable system carries is likely to exceed the number of services that can be trapped.

The exemption of cable services offered on a per channel or per program basis from rate regulation in Section 623(l) of the Communications Act will also affect the manner in which cable systems market their services. This exemption can be expected to encourage cable systems to expand the number of program services for which they need to provide individual channel protection.

C. Channelization

The channel plan used by cable systems has evolved over the course of many years, as cable systems have gradually increased their channel capacity. The earliest cable frequency plan used VHF channels 2 to 13, as allocated to the broadcast industry. Channels 2-4 are at 54-72 MHz, channels 5 and 6 are at 76-88 MHz and channels 7-13 are at 174-216 MHz. When the need for more channels arose, the so-called "mid-band" channels were established on frequencies in the band 120-174 MHz and designated channels 14 through 22. This portion of the plan was developed through a joint effort by NCTA and manufacturers that provide cable equipment. When the need arose for additional channels, 72 new channels were established in 6 MHz increments on the band 216-648 MHz. These channels were numbered 23 through 94. In the next addition, channels 95 through 99 were established on frequencies in the 90-120 MHz band.

At the advent of a technique called harmonically related carriers (HRC), channel 1 was established at 72-78 MHz and channels 5 and 6 were moved up 2 MHz, to 78-90 MHz. HRC refers to offsetting the video carrier downward 1.25 MHz and using harmonically related carriers for all video channels.[43] An additional 54 channels have been established by the JEC, the joint NCTA and EIA engineering committee, starting at channel 100 (648 MHz) and continuing in 6 MHz blocks up to channel 153 (1002 MHz). Table I shows the growth in the cable channel plan over time.

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[43] The HRC system uses a nominal master oscillator running at 6 MHz, thus maintaining a 6 MHz bandwidth for all video channels.

Channel Capacity	Time Period
12	Early 1960's
21	Late 1960's
30	Mid 1970's
36	Late 1970's
52	Early 1980's
60	1991
80	1992
100	1992
500	Mid-1990's

Table I: Growth in Channel Capacity of Cable Systems
(Source: Telecable Corporation)

The cable industry generally employs the EIA/ANSI IS-6 that was developed jointly by the EIA and the NCTA.[44] EIA IS-6 provides for 153 channels over the frequency range 54-1006 MHz, based on the evolutionary development of cable channel assignments as described above. The standard includes frequency assignments for standard, HRC and incremental related carriers (IRC).[45] The channels specified in this plan are in most instances different from the broadcast television channels. The intent of EIA IS-6 is to provide a standard plan so that the channels used by cable systems will correspond to the cable tuning capabilities of cable ready TV receivers and VCRs. As indicated above, EIA IS-6 is not, however, a mandatory standard and cable systems may use other channelization plans if they so choose.

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[44] A copy of EIA IS-6 is attached in Appendix F.

[45] The IRC system is based on picture carrier frequencies that start at 55.25 MHz and increment each channel by 6 MHz. The resulting frequency plan is the same as standard frequencies, except for the channels between 67.25 MHz and 91.25 MHz, which are 2 MHz higher than the standard channels. Both the HRC and IRC techniques place the unwanted carrier by products (i.e. second and third order beats) on the visual carrier frequencies in the system. This allows for an increase in the number of usable channels on a cable system by masking the effects of carrier by products with stronger visual carrier signals.

The actual number of channels activated by cable systems varies depending on factors such as the age and size of the cable system and the demand for programming by its subscribers.[46] The smallest systems have as few as 50 subscribers and offer only 12-20 channels of programming. The larger systems with more channel capacity naturally tend to be located in the larger markets. In the United States, approximately 60 percent of all subscribers receive between 30 and 53 channels. Another 35 percent receive more than 54 channels. There are several cable systems that operate on frequencies of up to 550 MHz, which allows for approximately 80 channels.[47] At least one system has recently been installed that operates up to 750 MHz and at least one other system is operating up to 1 GHz and offering 150 channels. Time-Warner states that it is not really possible to put an upper limit on cable channel capacity, and that future evolution will depend on technological advances as well as subscriber demand.

A common technique used today in building cable systems is to build "GHz ready" systems where the amplifier spacing is for 1 GHz, even though 550 MHz amplifiers are installed. The passive devices such as taps and splitters used with these systems are rated at 1 GHz also. The plan is to upgrade these systems to their full 1 GHz capacity when GHz amplifiers become more economical.

D. Remote Controls

As indicated above, the set-top devices used by cable systems are generally equipped to be commanded by infrared remote control units. Both manual and remote controlled versions of set-top boxes are available from cable equipment vendors. In newer cable systems and those that have been re-built in recent years, the same model of set-top box is generally used for both manual and remote control operation. Time-Warner states that this is because the majority of cable subscribers want remote controls and those who initially decline a remote control often

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[46] The vast majority of cable systems use a single cable to carry all of their signals. A few cable systems use dual cables. On dual cable systems, each cable has the same frequency complement and the total number of channels on the cable system is split between them. A dual 450 MHz cable system could carry 108 channels (2 cables x 54 channels).

[47] As indicated above, the channel plan used by cable systems starts at 54 MHz, and each channel is 6 MHz wide. The number of channels activated by cable systems may vary depending on system design and interference concerns with respect to signals available over-the-air in cable system's local area.

ask for it later. Using the same model of set-top box simplifies inventory and makes service upgrades easier. CAG further states that many cable remote controls are also "universal" devices. This type of remote control can be programmed to emulate any other remote control devices by placing the two units head-to-head and pressing the appropriate buttons. Universal remotes can be programmed or "taught" to operate any set-top device and thus can be used to operate other consumer devices, such as a TV receiver or VCR.

Time-Warner states that nearly all vendors of converters and converter/descramblers currently offer models that allow addressable control of the operation of the remote control from the headend. It submits that while there is additional expense in having addressable control of the remote control function from the headend, the ability to addressably disable a set-top unit with such equipment is just a simple software function.

The CAG and Time-Warner state that, although it is not a universal practice within the cable industry, many cable operators rent the remote control for their set-top boxes to their subscribers. CableVision Industries Corp. (CVI) indicates that the portion of subscribers with converters who pay a fee for remote controls is in the range of 40 to 50 percent. These parties indicate that the rental fees charged by cable systems for remote controls is typically $2-3 per month for each unit supplied.[48] In cases where a subscriber no longer desires to rent a remote control unit from the cable system, the operator generally turns off the remote feature of the set-top by sending an electronic signal to the set-top unit. Only a few cable systems sell remote control units to subscribers.

Remote controls capable of commanding set-top units are already widely available on the retail market. There are basically three types of remote control units currently available, not all of which will work with cable set-top units. The first type is specifically designed to work only a particular device or set of devices. The second kind of remote unit, often called a "multiband" remote, can be programmed to command specific set-top devices either by use of internal "dip" switches or by entering codes on the key pad. The third type is the universal remote, as described above. Universal remotes can replicate all set-top remote functions. Remote control units are widely available from many sources at highly competitive prices and have been for several years. After-market remotes range from $12.95 to $99.95 at retail; most sales fall in the $15 to $30 range.

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[48] These charges will be lower under the new rate regulations for cable systems, which specify that remote control and other equipment must be provided to subscribers at cost.

While specific penetration statistics are not available for remote controls, industry parties indicate that the market for replacement TV and VCR remote control units has been estimated at 5-8 million per year, and virtually all of those are capable of controlling set-top boxes. These parties also indicate that millions of new TV receivers and VCRs sold every year are equipped with remotes that are also capable of operating set-top cable devices.

VII. Features and Functions of Consumer Electronics Equipment

Features of current models of TV receivers and VCRs that can be affected by connection to cable service include:

- Tuner/channel selector range: The elements of tuner and channel selector performance that can be affected include the range of channels that can be tuned and operation of the channel selector. Current models of "cable ready" equipment generally can receive about 125 channels, including HRC and IRC cable channels. These 125 channels include the 12 VHF and 55 UHF broadcast TV channels and 58 cable channels. The cable tuning capability of most current models of this equipment follows the EIA IS-6 channel plan. Older receivers and VCRs with capability for direct connection to cable service tune smaller numbers of channels. Because the range of channels that cable systems can use is continually increasing, it has not been possible to ensure that a TV receiver will be able to receive all future cable channels. Consumer equipment manufacturers have generally responded to increases in the range of channels offered by cable systems by offering TV receivers and VCRs with increased tuning range. At the same time, it is also apparent that many, indeed most, cable systems have not upgraded their plant to the full range of channels specified in EIA IS-6. Thus, in many cases, the tuning range of existing consumer equipment may, in fact, exceed the range of channels offered on the cable systems with which the equipment is used.
- Reception quality: Direct pick-up interference from over-the-air signals can degrade the audio and video performance of TVs and VCRs with inadequate shielding. Almost all current models of TV receivers and VCRs do not have sufficient shielding to avoid DPU and therefore can be affected by this type of interference.
- Viewing and recording programs simultaneously: This affects all VCRs.
- VCR programmed recording, particularly recording sequential programs that appear on different channels: This affects all VCRs.

- Remote controls: TV receiver remote controls have the capability to control power, channel selection and volume. VCR remote controls have the capability to control operation of the tape playing functions and whether the unit is displaying video from the VCR's tuner/tape or passed through directly from an external program source. There is a wide range of variation in the inclusion of capabilities to remotely control other functions. Almost all current TV receivers have remote control capability except for small screen receivers. There is, however, a substantial population of older TV sets that do not have remote controls. Almost all VCR's have remote control capability.
- Closed captioning: Beginning in 1994, all new TV receivers with screens larger than 13" will be required to have closed caption display capability. All TV receivers with closed caption display capability and all VCRs are affected.
- On-screen display of channel numbers: Most new TV receivers and VCRs include this capability.
- On-screen programming for timed-recording: This affects almost all VCRs.
- Channel Autoprogramming: This feature allows the receiver to automatically select or omit channels from the line-up by scanning for valid signals. This feature is becoming standard on new equipment.
- VCR+ programming: This feature allows VCRs to be programmed for channel and time by entering a number provided in published program schedules in newspapers and TV Guides. This feature is included on a number of current TV receivers and VCR models.
- Program timer: This feature allows the user to set the receiver to turn on to a pre-selected channel at a pre-determined time and is becoming increasingly popular on new equipment models.
- Picture-in-Picture (PIP): There are two kinds of PIP features currently being incorporated into consumer equipment. The first merely places a small picture of programming on one channel inside the larger picture of the primary programming the viewer is watching on another channel. This allows the viewer to monitor the secondary programming. Sound is provided only for the primary picture. The second type of PIP feature cycles the receiver's tuner through multiple channels, repeatedly displaying still pictures from each channel on the screen. This serves as a sort of monitoring feature or program guide for programming on the other channels. PIP is now incorporated in about 20 percent of all new TV receivers; about 10 percent of U.S. households own such receivers. Information about the relative mix of the two types is not available, nor do we know whether this feature is actually used to any significant degree.

- On-screen display of channel labels: This is a tuner feature that displays the name of each station or program service after a channel change. The user can program the channel names or call letters of each available station or program service. Mitsubishi states that this feature is included on 11 of its 36 current receiver models and on 2 of its 5 current VCR models.
- Channel review: This is a tuner feature that allows easy, one-button access to the most recent channel selected. Many current receivers and VCRs include this feature. There is also a more advanced version of the channel review function that includes a user programmed table of frequently accessed channels.
- Home Theater Mode: This feature allows external video processors or switching devices to be connected to the receiver while the receiver maintains all tuning features and functions. This feature is included on many current mid and higher priced receiver models.

The more advanced extended features generally are available on more expensive products, in the case of TV receivers usually those with screen sizes of 25 inches and above. EIA states that a recent consumer survey reveals that nearly 70 percent of basic cable subscribers and 75 percent of subscribers that take additional cable services would be unlikely to buy TV receivers with this and other advanced features if they could not use them because of incompatibility with their cable service.

Manufacturers indicate that additional new features to be included in 1993 models of equipment that will be affected by connection to cable service, include:

- Auto Channel Naming: This feature will use data contained in the video signal to automatically provide channel names.
- Auto Clock Setting: This feature uses data contained in the video signal to automatically set the receiver's or VCR's internal clock. During the initial set-up, the unit will scan the available channels to search for a clock signal. It will also return to this channel after any extended loss of AC power.

Equipment manufacturers also indicate that there are a number of possible future enhancements to consumer TV receivers and VCRs that could pose compatibility difficulties with existing cable operating and security technologies. These include:

- High Definition Television
- Multimedia, a family of ancillary services that can present full and partial screen video and textual information and also includes digital processing

capability that could support operation of software and access to data bases related to the video service.
- Program guides with automatic VCR recording features
- Extended Data Services (EDS) using line 21, Field 2
- Faster tuning algorithms for improved PIP (channel guides, etc.)
- Picture-outside-Picture (on 16:9 aspect ratio receivers, to fill space when viewing 4x3 NTSC programming)
- Channel scan (a Picture-outside-Picture feature)
- Other proprietary features in 16:9 receivers
- Scan-by-format
- Point-and-click ("air mouse")

VIII. The Nature of Compatibility Problems

A. Compatibility Issues Relating to Set-top Devices and Security Systems

The most significant problems of compatibility for consumer equipment arise as a result of the use of set-top devices, both converters used to resolve signal ingress and egress problems and converter/descramblers used with scrambling security systems. The basic problem with both types of set-top devices is that the commonly available units provide only a single output channel, usually channel 3 or 4, and their tuner generally cannot be controlled by TV receivers, VCRs and other equipment. The set-top box effectively disables the channel selector functions of consumer equipment that follows it in the program delivery path. An additional related problem is that most converter/descramblers only descramble one channel at a time.

Set-top boxes with these limitations, which include most existing units of such equipment, render inoperative extended features of TV receivers and VCRs that use more than one program channel at the same time. These features include important inter-device operations such as watching one program channel while simultaneously recording another and timers in VCRs that change channels automatically to allow recording of two or more different channels at different times on a preset schedule and other features that depend on tuner control and simultaneous access to multiple signals such as timers and PIP. Security systems other than scrambling that do not use set-top boxes, such as traps, interdiction and the developing scrambling systems that use broadband descramblers to deliver all signals in the clear, generally do not pose these compatibility problems for consumer electronics equipment.

VCR operation is incompatible with set-top units because the VCR cannot control the channel being recorded in this set-up. The only signal available to record is the single channel to which the set-top unit is tuned. This precludes operation of VCR

features that change channels to record programs on different channels at different times. It also precludes recording of a channel that is different from the channel being watched on a TV receiver served by the same set-top box, and recording of programs on two different channels at the same time by two separate VCRs. In order to record sequential programs on different channels, a duplicate timer with channel change capability is needed in the set-top box.

Scrambling systems sometimes make it more difficult for the closed caption decoders of TV receivers to locate closed captioning signals in programming. This problem persists despite the Commission's attempts to address the closed captioning problem through allocation of specific responsibilities to both the cable and consumer equipment industries.[49]

The majority of TV receivers equipped with PIP do not come with two tuners. The second picture is generally obtained from baseband inputs on the back of the TV set. Typically, the second channel of video for these receivers comes from a VCR. In such cases, the VCR's tuner is used to select the second channel. If PIP is to be used for two scrambled pictures, the TV and VCR must both have descramblers. Similarly, in cases where a PIP equipped TV receiver has two tuners, two descramblers are needed for the PIP feature to work with two scrambled channels. The second type of PIP with multiple channels will not work with a set-top converter/descrambler because the TV receiver cannot change the converter's channels.

Multiplex Technologies states that set-top converters disable the ability of consumer multiplex systems to provide consumers with full access to and control of cable programming in conjunction with other video sources. This problem results because set-top boxes provide only a single output channel, rather than simultaneously deliver all purchased channels.

B. Compatibility Problems Relating to Channelization

The primary problem with channelization for consumer equipment is that the number of channels delivered by cable systems varies across systems and is increasing over time. As a result, a receiver marketed as cable ready may in fact not be able to tune all of the channels activated by a cable system to which it is connected. Moreover, the channel capacity of a TV

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[49] See 47 C.F.R. §§15.119(1) and 76.606. There are no similar measures to avert compatibility problems in the case of teletext, extended data services and ghost canceling features, all of which use the vertical blanking interval.

receiver or VCR that was adequate at the time it was purchased may not be adequate some time later if the cable system changes.

There is also potential for additional compatibility problems if and when cable systems implement digital compression techniques that significantly increase the number of programs that can be carried. EIA indicates that consumer electronics manufacturers are willing and able to build new products that adapt to this new technology. However, the introduction of multiple non-standard digital transmission and compression techniques could worsen the compatibility problems for both the installed base and new consumer equipment, particularly if such techniques are implemented in a manner that employs set-top devices.

A second problem relating to channelization involves channel "mapping," or assignment of channel numbers to specific frequencies, by cable systems. While most of the cable industry uses the EIA IS-6 channelization plan, there is no requirement to do so.[50] Thus, it is possible for a cable system to locate a channel that the consumer perceives as one channel number to be delivered on another channel by the cable system. For example channel 12 might be delivered on channel 37. EIA contends that because there is no mandatory standard for mapping channels on cable, it is not possible to incorporate mapping capability in a TV receiver, VCR or "universal" converter box that will always match the channelization used by cable systems. So long as cable systems employ the EIA IS-6 plan, however, the channel mapping problem generally would not be expected to occur.

Slight irregularities in cable systems can cause the carriers of video signals to mix and produce interference components. Some channelization plans place these interference components in places which minimize the impact on picture quality. This is the motivation for the HRC and IRC channel plans. Time-Warner indicates that these techniques made channel expansion possible prior to the development of more linear amplifiers. At present, these techniques are not considered necessary in new construction or upgrades that replace older amplifiers. Probably less than 15 percent of cable systems use these channelization plans. Moreover, these channelization plans are likely to fade away as those systems that now employ them are rebuilt. They cannot be eliminated until then without a significant degradation in picture quality for systems that use them. The potential for impact of the HRC and IRC plans on TV receivers and VCRs is on their tuner only. A well designed

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[50] EIA indicates that a new extended data service feature to be included in TV receivers and VCRs may offer a means to "educate" consumer equipment to the mapping of frequencies used by cable systems.

computer controlled tuner has no problem with these frequency plans.[51] Earlier versions of tuners include manual switches that have to be set to the appropriate position for the channelization plan used by the cable system. New tuners usually only require only an indication of whether they are connected to an antenna or cable service; some models are fully automatic. Channelization effects the extended features of TV receivers or VCRs only to the extent that a consumer's equipment might not be able to tune a channel that would be used with a particular feature.

C. Compatibility Problems for Consumer Equipment Caused by Current Tuner Designs

Inadequacies in the design of a TV receiver or VCR can cause the unit to experience operating problems when connected directly to cable service. Several types of problems can occur. First, if a unit's tuner is not designed to accept high RF energy broadband signals of cable service, it can "overload." Overload typically results in the combining of signals from several channels in a manner that produces disturbing "ghosting," or moving background patterns and bars in the picture.[52] Second, if a tuner does not have adequate adjacent channel rejection capability, interference will occur with cable service that does not appear with over-the-air reception. The interference in this case is from signals on adjacent channels. This occurs because cable systems use contiguous channels, whereas the over-the-air broadcast service does not use adjacent channels in the same area. The final problem in this area is DPU. This type of interference results from inadequate shielding of the internal circuits of a TV receiver or VCR. When DPU occurs, radio signals present in the local area are picked up off-the-air and mixed inside the unit with a desired cable signal. This unwanted mixing typically degrades the desired programming and can make it unwatchable. This problem becomes more acute as the frequency of the desired channel increases.

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[51] Nearly all cable systems use frequency offsets to comply with the Commission's regulations relative to the aircraft navigation and communication bands. See 47 C.F.R. §§76.612 and 76.616. The computer controlled tuners of current receiver models are also able to correct for these offsets.

[52] Cable converters avoid this problem by using special front-end circuitry to handle high energy broadband signals and a more expensive "double conversion" tuner that eliminates "image response." Cable converter tuners also typically have a lower "noise figure" that introduces less "snow" into the picture than TV receiver and VCR tuners.

D. Effects of Consumer Equipment on Cable System Operations

A number of aspects of consumer equipment performance and features can affect the operations of cable systems. Most of the concerns in this area relate to the tuning capabilities of consumer equipment. First, if the internal circuits of a TV receiver or VCR are not properly shielded, the unit can leak broadband cable signals. This can lead to the cable system exceeding the Commission's "cumulative leakage index" standards,[53] posing a threat of interference to the operation of other over-the-air radio services, including air navigation and communications and public safety communications. Another important factor in cable signal leakage is the level of signal isolation provided by switches used in consumer equipment to select between cable service and other alternative sources of programming. Inadequate RF isolation performance in a source selection switch can result in leakage of cable signals to other output ports of the switch. The leaked signals can then be radiated through the equipment connected to those ports.[54] As with direct signal leakage above, leakage through associated equipment, especially antennas, can cause the cable system to exceed the Commission's cumulative leakage index standards.

The third area of concern for cable system operation from consumer equipment is feedback of RF signals generated within the consumer equipment. These signals can originate in the tuner's local oscillator, color oscillator and digital circuitry. Such signals can be transmitted through the cable plant and may cause reception problems on other TV sets and VCRs connected to the cable system. Finally, if a TV or VCR employs signal splitters, there is potential for the signals to be divided unevenly. In such cases, the signal from the weaker side of the port would appear degraded or not usable at all. Broadband cable signals weakened after passing through an uneven splitter would not support acceptable service.

IX. Views of Industry and Other Parties for Improving Compatibility Between Cable Service and Consumer Equipment

The Commission asked industry and other interested parties to provide information on various issues relating to the development of an appropriate regulatory plan for assuring

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[53] See 47 CFR §76.611.

[54] Sections 15.115 and 15.117 of the Commission's rules currently specify standards for transfer switches included in TV interface devices (which include VCRs) and TV receivers, respectively. See 47 CFR §§15.115 and 15.117.

compatibility between cable systems and consumer television equipment, considering our basic principles and goals as indicated above.

A. General Viewpoints and Suggestions for Regulations

1. Views of the Cable and Consumer Electronics Industries

Industry parties emphasize that the issues in this proceeding are of great importance to the consumer electronics industry, the cable industry and consumers. Parties representing the cable and consumer electronics industries have differing views, however, on the approach the Commission should use to ensure compatibility between cable service and consumer electronics products. These differences reflect their positions on the cause of compatibility problems and who should bear responsibility for resolving them.

Tele-Communications, Inc., (TCI), in statements generally summarizing the position of the cable industry, submits that the complex compatibility problems in this matter are due in large part to the unsynchronized technology cycles of the cable and consumer electronics industries. Time-Warner similarly states that the processes for introduction of new technologies in the two industries are fundamentally different. These parties observe that on the consumer electronics side, consumers purchase and own products for an extended period of time. They note that TV receivers often last for 15 years or longer, while VCRs have shorter lives, perhaps 3 to 5 years, because their mechanical components wear out. They state that cable equipment is introduced at the time of a system rebuild or when technology makes possible new or expanded services that subscribers demand. Finally, these parties point out that subscribers do not purchase all new equipment when their cable system implements new hardware. TCI states that to address this technological disjunction, cable operators have been forced to employ set-top devices in subscribers' homes to enable them to tune additional cable channels or to overcome other deficiencies of consumer TV receivers and VCRs. It further states that more recently, cable operators have deployed scrambling systems that use set-top descramblers to protect the security of programming.

According to NCTA, the challenge in this matter is to regulate two industries with vastly different attitudes towards marketing. It states that the consumer electronics industry on the one hand has a transaction based attitude that emphasizes new features and regular introduction of new models to promote sales. The cable industry, on the other hand, is composed of 11,000 cable systems, each with cable plant that has a useful life of many years. NCTA further states that cable operators also have an ongoing relationship with their subscribers, which is

different from the generally single, point-of-sale contact market served by consumer electronics manufacturers. NCTA believes it is these differences that have led to incompatibility of product offerings between the two industries.

TCI states that the most appropriate solution is a middle ground where both equipment manufacturers and cable operators share the responsibility of achieving compatibility. It further states that the Commission's goal must be to achieve compatibility in a way that does not impose excessive costs on the industries involved and ultimately consumers. Time-Warner contends that in striking a balance between cable and consumer interests, the Commission should acknowledge that legitimate cable security needs outweigh the convenience of certain optional features that are included on some high-end consumer electronics equipment. Time-Warner similarly states that it would be unreasonable to limit the introduction of new cable services such as pay-per-view, that need to be protected with security systems, just to prevent a requirement for the subscriber to make a choice that may involve the purchase or rental of new or supplemental equipment.

The cable industry strongly opposes any restrictions on the use of scrambling technology. The cable industry argues that cable operators need, and should be afforded, the maximum flexibility in determining which security measures best protect valuable programming and satisfy subscriber compatibility demands. The Community Antenna Television Association (CATA) observes that cable systems will soon face competition from other broadband video distributors and cable operators must have the flexibility to choose technologies that enable them to best meet those challenges. Continental states that scrambling provides cable operators the same security measure that the Commission allows for wireless cable, home satellite dishes and even video dial tone.[55]

The consensus of the cable industry, as expressed by NCTA, however, is that the rigors of the market have lead the cable industry to believe that scrambling is the most valuable of the currently, or soon to be, available technologies. NCTA and Time-Warner submit that the demand for increased programming, increased channel capacity and new marketing approaches, such as impulse pay-per-view, make addressable scrambling the most attractive security technology for cable operators. They further believe that addressable scrambling may be the only technology sufficiently flexible to enable cable systems to comply with the 1992 Cable Act's must-carry/retransmission consent, channel

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[55] Michigan Bell's "ThinkLink" video dial tone service requires a descrambler in the home.

positioning and buy-through provisions and to accommodate the deployment of new services such as IPPV and NVOD.

NCTA states that other security techniques such as trapping and interdiction are either too limiting or have not been adequately tested in the real world to be considered satisfactory alternatives. Time-Warner is concerned that any restrictions on scrambling could harm the program service and technological diversity Congress intended to foster in both the 1992 Cable Act[56] and the earlier Cable Communications Policy Act 1984[57] and could also increase customer costs. It states that limitations on scrambling would not only require that an enormous investment in equipment be written off, but also require customers who are currently paying for the deployment of that equipment to bear the costs of its replacement. Cable industry parties generally argue that the compatibility objectives of Section 17 can be achieved with existing technology and consumer education and without the need to restrict scrambling.

Time-Warner, Continental and other cable industry representatives oppose the imposition of a national scrambling standard. Time-Warner states that the most troublesome problem with this approach is the lack of alternatives if the scrambling technology is defeated. It observes that the experience thus far is that every signal protection scheme, over time, has suffered an increasing degree of compromise as pirates develop and market unauthorized illegal devices.[58] Similarly, the cable industry also opposes any rule that would require descramblers to be made available for purchase by consumers. Time-Warner states that the proprietary nature of this equipment is crucial to the cable industry's ability to combat theft of service.

Time-Warner further submits that diversity in scrambling methods is a security technique in itself. It states that diversity in methods complicates the task of those who would

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[56] See 1992 Cable Act, supra, at Section 2(b)(1).

[57] See Cable Communications Policy Act of 1984, Pub. L. No. 98-549, 98 Stat. 2779 (1984), at Section 601(4).

[58] Time-Warner submits that an Office of Cable Security and Theft (OCST) study indicates that in 1991, 1,300 theft of service cases were prosecuted nationwide on the federal, state and local levels. According to Time-Warner, this study found that 75 percent of the more than 250,000 devices seized by law enforcement agencies in these cases were capable of defeating addressable technology to allow illegal viewing of pay-per-view services. Time-Warner states that the OCST study estimates that each illegal decoder sold to a consumer costs the cable industry approximately $3,108 over the decoder's useful life.

develop technology to defeat the scrambling systems cable systems use.[59] It points out that in contrast to the provisions regarding remote controls, the 1992 Cable Act does not require that descramblers or other security hardware be made commercially available. Finally, Time-Warner also believes that if a national scrambling standard were imposed and later compromised, subscribers would focus their anger on cable systems for the need to revert to set-top equipment that would again render features of their equipment unusable.

Cable industry representatives also argue that the Commission should not restrict the use of set-top devices. Continental submits that set-top devices provide many benefits to cable subscribers and their use has allowed cable operators the flexibility to increase the range of channels they use and to provide service on those additional channels to receivers with fixed tuning ranges that cannot tune extended channels. Cablevision Systems Corporation asserts that the use of devices external to consumer electronics equipment is the most efficient and effective means of ensuring compatibility with cable systems.

NCTA submits that no single approach will provide a "100 percent" solution to every compatibility problem between consumer electronics equipment and cable security technology. NCTA and Time-Warner believe that many compatibility problems can be resolved to a large degree with existing technology, and in ways that are consistent with the need to protect against signal theft. Cable industry representatives generally believe the best plan for a long term solution involving new equipment is to employ the EIA/ANSI 563 Decoder Interface with component descramblers. NCTA also argues that the Commission should not limit channel expansion beyond the 550 MHz range (82 cable channels) or limit this range to compressed digital signals only.

NCTA also observes that the Commission could also choose to follow the lead of the 1992 Cable Act and provide for different compatibility requirements depending on the service tier. For example, NCTA submits that the basic service tier may legitimately be subject to more stringent compatibility requirements than other tiers.

Time-Warner, CATA, Continental, TCI and others submit that the Commission should take this opportunity to require both the cable and consumer electronics industries to make their customers aware of potential compatibility problems and available means of

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[59] Time-Warner states that currently there are at least ten different scrambling systems available. It states that it now uses systems available from Zenith, Scientific-Atlanta, Pioneer, Jerrold and Oak. Each of these manufacturers produces both RF and baseband scrambling equipment.

resolving those problems at the time the consumer equipment is purchased and at the time cable subscribership commences. Time-Warner suggests that the cable and consumer equipment industries work together to create a joint notification program that will advise consumers of compatibility problems and potential solutions. Such notifications would include information on the use of by-pass switches, descramblers with built-in timers, remote controls with built-in timers, VCR-Plus type devices and multiple descramblers. Under this plan, compatibility information would be provided to consumers at the initiation of cable service and when they purchase new electronic equipment.

Continental believes that, to avoid unnecessary costs, cable operators should be allowed to include the required notices advising cable subscribers of the option of buying remote control devices from third parties with other notices (privacy and Section 76.607 complaint notices) that are issued to new subscribers and thereafter be required to be provide the notices on an annual basis. It also observes that there are a wide variety of alternative models of remote controls available. Because of this, Continental argues that cable operators cannot reasonably identify particular brands or models of remote controls that are compatible with the cable system's set-top units. It recommends that the cable system be required to indicate only the model of converter or converter/descrambler units it employs and that the responsibility for determining compatibility with the various models of set-top devices be left with the manufacturers of remote control devices.

Continental indicates that in its experience, the remote control features of set-top units typically need to be enabled, often repeatedly, such as after power outages. It states that transaction fees may be justified to compensate cable operators for this service. Continental further points out that due to the large number of consumer devices now controlled by wireless (infrared) remotes, some subscribers request that the remote control feature of their set-top unit be disabled to eliminate undesired activation by other IR remote control units. It submits that cable systems should be allowed to disable set-top remote control functions when requested by a subscriber.

The EIA's position is that compatibility problems arise because cable "rations" consumers, via set-top boxes, to reception of a single channel at a time. It further argues that the present trends in cable technology are ominous for compatibility: fewer channels are being delivered in the clear, diverse scrambling technologies are being used, set-top boxes are proliferating and various digital compression technologies are being readied for deployment. EIA states that these circumstances make it increasingly difficult to design full-featured consumer products for a national market. Matsushita and Mitsubishi Electronics America, Inc. (Mitsubishi) believe that

both the cable and consumer equipment industries must change their current practices. They state that the cable industry must embrace standards for signal delivery technologies and the consumer electronics industry must build "media independent" receivers that serve both cable and terrestrial broadcasts.

The consumer electronics industry generally believes that the only way to give full function to consumer equipment is if all authorized cable signals are simultaneously available "in the clear" in a standardized format. The EIA recommends that compatibility be regulated by requiring use of cable security technologies that do not involve use of set-top boxes. Consumer electronics industry representatives submit that point-of-entry security methods such as traps, interdiction, broadband descrambling and, in the future, a national scrambling standard, that deliver signals to subscribers "in-the-clear" all provide acceptable means for preventing theft of cable service while avoiding compatibility problems.[60] They state that these methods simultaneously present all authorized programs to the consumer's equipment, thereby allowing use of all of that equipment's features. These parties state that point-of-entry methods also allow cable operators to levy flexible charges and at the same time permit consumers to avoid the inconveniences and redundancy of security systems based on scrambling and set-top devices. The National Electronics Service Dealers Association (NESDA) states that like telephone service, cable subscribers should be able to buy and, independent retailers should be able to sell, TV receivers and VCRs that plug directly into a cable outlet. It argues that all the special features and accessories should work with cable service right out of the box.

The EIA also believes that the Commission should be attentive to the characteristics of the enormous installed base of TV receivers and VCRs.[61] It states that there is no practical way of modifying this equipment to make it fully compatible with cable service.

The EIA states that the Commission should focus on three interrelated objectives:

- Enable consumers to use and enjoy the functions of their electronics equipment, now and in the future, with a growing range of cable and other video services.

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[60] EIA also states that dual-tuner converters could serve as an adjunct to the other measures, if used only at the subscriber's option.

[61] EIA submits that there are approximately 200 million TV receivers and 100 million VCRs in use now in the United States, representing a consumer investment of more than $100 billion.

- Promote continued competition and innovation in consumer electronics products.
- Prevent cable companies from imposing unnecessary burdens on consumers or on consumer electronics manufacturers.

EIA, Mitsubishi and the NESDA argue that the fundamental problem that led Congress to enact Section 17 is the lack of standards governing the characteristics of the signals cable systems deliver to their subscribers. EIA observes, for example, that in any given cable system, one or more signals may be scrambled using any one of several different scrambling systems and that signals may be transmitted to subscribers on channels different than their over-the-air channel numbers. In addition, the number of channels on a cable system may change and various digital transmission and compression methods may be introduced. EIA, Mitsubishi, Thomson and other consumer equipment manufacturers submit that given these variations in cable systems, it is not practical to design consumer electronics products that are compatible with each characteristic of every cable system. They contend that this variability in cable system technical characteristics is the principal problem that the Commission needs to remedy.

Zenith Electronics Corporation (Zenith) recommends that the Commission pursue a long term solution that would require consumer equipment manufacturers to offer some models of large screen receivers cable ready, which would include an intermediate frequency (IF) interface port. Cable systems would be required to offer subscribers appropriate set-back modular decoder units to operate with this interface. The interface suggested by Zenith would be updated from the EIA/ANSI 563 Decoder Interface standard.

Mitsubishi suggests that the Commission impose a moratorium on the introduction of new cable services until rules are in place on channelization, signal security and transmission and compression formats. It states that without such a moratorium, the confusion that now exists will intensify.

The EIA offers a plan for fulfilling the statutory requirement that the Commission adopt rules to promote the commercial availability of converter units and remote controls. The first step in this plan would be to prohibit cable systems from disabling their set-top boxes from responding to remote controls. The EIA states that this would foreclose the anti-competitive practice whereby a cable system can use the power to disable the remote control function of a set-top unit to force subscribers to rent a company-supplied remote. The second step in the EIA's plan would be to require cable systems to disclose information needed to permit successful interoperation between set-top units and remote controls obtained from third parties. Under this suggestion, manufacturers would provide, and the

Commission compile and publish, a complete listing of IR codes to enable such interoperation. Finally, EIA states that new IR codes should not be used to control existing functions (channel selection, volume control, etc.) and that any new codes and provision for expansion should be developed through ANSI-accredited forums. The EIA states that this last suggestion would help to avoid causing uncontrolled obsolescence of competitively supplied remotes. Sony recommends that the basic IR codes for cable remote controls be standardized.

The cable and consumer electronics industry respondents generally recognize that the Commission could implement some aspects of the cable equipment compatibility rules sooner than others. NCTA and Time-Warner propose that the Commission's rules generally implementing Section 17 take effect within 18-24 months following the date they are adopted, with some rules such as the notification requirements taking effect sooner. Time-Warner submits that a Decoder Interface connector requirement should be implemented as soon as possible. The EIA submits that the requirements for consumer notification, wiring option and promoting of set-top converter and remote control availability could be promulgated within several months. It also suggests that an intermediate time frame may be appropriate for implementation of the definition of cable ready consumer equipment.

As indicated above, the Cable-Consumer Electronics Advisory Group submitted supplementary comments presenting joint recommendations of the cable and consumer electronics industries for regulations to implement Section 17. In this filing, the CAG submits that the Commission's policies addressing compatibility issues will need to incorporate reasonable timetables; that interim measures can provide relief from compatibility problems for existing and new non-cable ready TV receivers and VCRs; and that more fundamental longer term solutions are also needed. The CAG plan includes short term measures for improving compatibility for existing equipment and longer term measures that require substantial changes in consumer electronics equipment.

2. Views of Other Video Media Parties

A number of parties representing other media, including Ameritech, BellSouth and the United States Telephone Association (USTA) caution that, while it is appropriate to frame the equipment compatibility matter on balancing consumer interests in equipment functionality with the security interests of cable operators, regulation in this area should also be designed with consideration for its effects on new services. These parties argue that compatibility issues are not just a cable industry problem. They believe that regulatory parity in equipment requirements would maximize consumer benefits by minimizing incompatibility between multiple broadband delivery systems and

consumer electronics used in the home. Ameritech and BellSouth state that one way to accomplish these objectives is to bring all the trade associations, under a common umbrella organization, to establish appropriate compatibility standards. This would include computer companies, consumer electronics companies, telephone companies (video dialtone providers), cable systems, wireless cable systems and broadcast television stations. The USTA observes that multiple lines of narrowband telephone service can be accommodated within a home or office using one instrument that can be produced by a multitude of manufacturers and that there is no reason why the same cannot also work for delivery of video program service via cable systems.

Ameritech states that the equipment compatibility rules should be formulated so as to maximize the availability of new services. Ameritech specifically states that the new rules should be developed with consideration for their effect on the embryonic video dialtone service. It submits that video dialtone has the potential to be an important alternative to traditional cable service, but that potential will not be realized if rules are adopted that mandate a particular technology or that dramatically increase the cost of video dialtone service. BellSouth believes that the consumer electronics equipment compatibility standards and related network disclosure obligations should be the same for all video delivery systems into the home.

BellSouth and Bell Atlantic also state that the Commission should adopt network disclosure obligations for cable systems and the rest of the home video industry that would parallel the Commission's network disclosure rules for the former Bell Operating Companies (BOCs). Those rules require that BOCs publicly disclose new network services and interfaces which affect the interoperability of customer premises equipment or advanced services before introducing those services. BellSouth suggests that the Commission require that public disclosure of relevant network service information must take place twelve months prior to the introduction of a new service or interface, unless public disclosure is made at the "make/buy" decision, in which case public disclosure need be only a minimum of six months prior to introduction.

MCSI and Philips submit that the Commission should use incentive based cable rate regulations to encourage cable operators and their equipment suppliers to invest in technologies that solve the compatibility problem. They state that in adopting cable rate regulations, the Commission should distinguish between general categories of cable service. In particular, MCSI states that a separate category for "simultaneously clear addressable tiered services" (SCATS), the provision of which it believes will fully address compatibility problems caused by set-top devices, should be established to

account for its differing beneficial characteristics as compared to services requiring set-top descramblers. MCSI and Philips believe the Commission should establish higher than average rate benchmarks for systems that use SCATS technology. They submit that a separate rate structure would ensure that undue financial burdens are not imposed on cable operators that implement technologies such as its broadband descrambling.

3. Views of Local Franchising Authorities and Consumer Representatives

The Joint Local Governments and the City of New York urge the Commission to consult with a inter-industry committee composed of representatives of local franchising authorities, the cable and consumer electronics industries, and consumer organizations on a regular and ongoing basis in developing and reviewing policies for ensuring cable compatibility with consumer equipment. This group would work towards setting appropriate interface standards and would help the participating industries educate and advise consumers regarding equipment compatibility problems. The City of New York states that this committee could build on the work of the CAG.

The Joint Local Governments recommend that the Commission take the following actions: 1) prohibit cable operators from taking actions to secure signals that are incompatible with subscribers equipment if such actions are not necessary to protect the signal; 2) mandate that set-top devices and cable signals be more compatible with consumer equipment; 3) ensure that TV receivers and VCRs have certain minimum capabilities in order to be considered cable ready; and, 4) explore the extent to which standardization of certain cable and consumer electronics equipment might further a solution to the equipment compatibility problem.

The City of New York submits that, in response to growing frustration among consumers, it has investigated problems in the compatibility of consumer electronics and cable system equipment and has taken a number of steps to address these problems.[62]

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[62] In November 1991, the City of New York released a report with recommendations on the results of its investigation. In this report, a copy of which is attached as Appendix I, the City determined that:

1) The use of set-top boxes to descramble signals represents state-of-the-art technology in the cable industry. It also represents an important and necessary means to combat extensive theft of cable service in New York.
2) Addressable descrambler technology also offers consumers the convenience of upgrading or downgrading their service